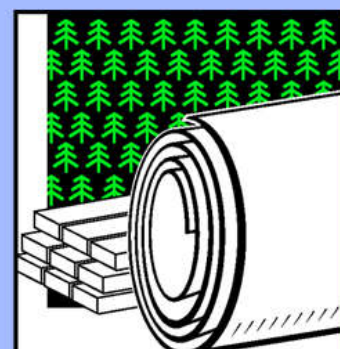
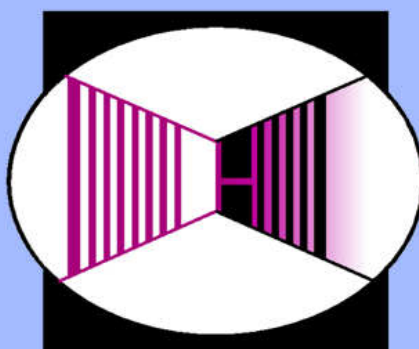
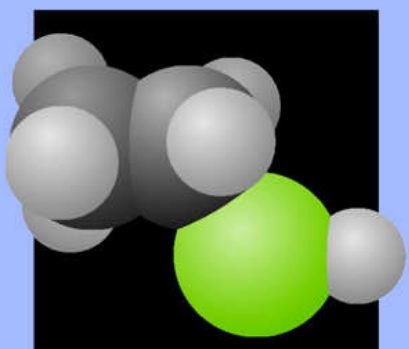


Proceedings

Energy Performance Workshop for the Chemical and Pulp and Paper Industries, 2000-2020



Hyatt Regency Cincinnati
Cincinnati, Ohio

September 1-2, 1998



Office of Industrial Technologies
Energy Efficiency and Renewable Energy
U.S. Department of Energy

PROCEEDINGS

**Energy Performance Workshop for the
Chemical and Pulp and Paper Industries, 2000-2020
September 1-2, 1998
Hyatt Regency Cincinnati, Cincinnati, Ohio**

October 16, 1998

CONTENTS

	<u>Page</u>
1. Summary	1.1
1.1 Workshop Goals	1.1
1.2 Workshop Organization	1.2
1.3 Opportunities Discussion Group Report	1.2
1.4 Technologies Discussion Group Report	1.3
1.5 Where Do We Go From Here?	1.4
2. Letter of Invitation	
3. Agenda	3.1
4. Participants	4.1
5. Discussion Groups	5.1
5.1 Organization and goals	5.1
5.2 Discussion Group 1A (Red) - Energy Opportunities	5.2
5.3 Discussion Group 1B (Blue) - Energy Opportunities	5.8
5.4 Discussion Group 2A (Yellow) - Energy Technology Needs	5.14
5.5 Discussion Group 2B (Green) - Energy Technology Needs	5.19
6. Closing Session Comments	6.1
7. What Comes Next?	7.1
8. Reference Materials	8.1
Appendix A Speakers and Their Presentation Viewgraphs	
Appendix B Workshop Evaluation Results	

1. SUMMARY

1.1 Workshop Goals

The Office of Industrial Technology (OIT) within the U.S. Department of Energy (DOE) hosted the Energy Performance Workshop to serve three disparate but complementary goals. These three objectives represent the needs of the chemical industry, the pulp and paper industry, and those of the Office of Industrial Technology itself.

Significant planning efforts are underway within the chemical and pulp and paper industries to improve their competitiveness over the next 20 years. The chemical industry produced the “Technology Vision 2020, The U.S. Chemical Industry,” which looks at a variety of industry issues but does not significantly address energy use.¹ Cogeneration is already used to a great extent within this industry, although further potential exists.² Gasification technology is also already in place within this industry, but again new technologies and applications offer significant potential for improved efficiency. *The chemical industry is therefore concerned with addressing their energy issues explicitly and opening up the current energy paradigms for reconsideration throughout the industry.*

The pulp and paper industry’s efforts have produced “Agenda 2020, A Technology Vision and Research Agenda for America’s Forest, Wood, and Paper Industry,” which addresses the energy issues in much greater depth.³ The pulp and paper industry already makes significant use of biomass resources with their processes. The industry’s planning efforts have identified new technology options. Also, the aging of their existing equipment presents important near-term opportunities for process improvements. These opportunities are counterbalanced by two significant obstacles, one financial and the other technical in nature. First, the financial challenges include those associated with introducing a new technology into an established business. Second, although gasification and combined cycle power generation are relatively mature technologies, there are specific new issues associated with the chemistry of the pulp and paper processes that require new research and development efforts. The industry, recognizing the scope of these challenges, has appealed to government science agencies for assistance. Industry and government partnerships will foster the advancement of high-risk technologies that offer significant energy efficiency, environmental, and economic benefits. Additionally, cross-governmental involvement will also help leverage limited financial resources. *The pulp and paper industry is therefore concerned with identifying technology issues that would advance energy goals within other industries as well as its own and also with identifying other possible sources of government aid that would help address the remaining financial and*

¹Technology Vision 2020, The U.S. Chemical Industry, American Chemical Society, Washington, DC (www.acs.org), December 1996

²Advanced Turbine Systems Chemical Industry On-Site Power Market Assessment, Onsite Energy Corporation, Carlsbad, California, January 10, 1997

³Agenda 2020 A Technology Vision and Research Agenda for America’s Forest, Wood and Paper Industry, American Forest & Paper Association, Washington DC, November 1994

technological obstacles they've identified in their planning process.

The OIT has instituted the Industries of the Future strategy to align industry and government resources and apply them toward industry's top priorities. OIT is establishing long-term partnerships with the most energy intensive and waste producing industries. These partnerships will improve energy efficiency, environmental performance and economic benefits of U.S. industries, including both the chemical and pulp and paper industries. As prudent shepherds of the government's resources, the Office is concerned with directing technological and financial resources toward those items that will have the greatest effect on industry's energy use now and in the future. It is also appropriate that the government fund research efforts that would not be funded in the ordinary course of business by the affected industries. *The OIT is therefore motivated to seek industry assistance in identifying those research goals that have the highest priority, those that offer the most return for the investment yet have an element of risk that would preclude their support as an ordinary business investment.*

1.2 Workshop Organization

Recognizing the significant overlap in the energy technology options under consideration in both the chemical and pulp and paper industries, namely gasification and combined-cycle power generation, the OIT sought to address these three goals by organizing the workshop described in these proceedings. Representatives from the chemical, pulp and paper, gasification, and utility industries were invited to discuss possible avenues of cooperative research.

To establish a common foundation for the discussions, plenary sessions were arranged to review the current state of the technology within each industry. Speakers were invited to present information about on-going projects and also to describe current government research efforts in related fields. A panel of gasification companies was formed to describe the current state-of-the-art and to inform the participants about installations already in place. Thus current capabilities, as well as the industries' wish lists, were given an overview before the discussion sessions began.

Given the differing goals of the two participating industries, two separate discussion topics were arranged. The first looked at the overall issue of identifying energy opportunities within the two industries. This topic was intended to facilitate a broad and open discussion of the ways these industries use energy, thus identifying new opportunities to improve their energy efficiency. These groups addressed the issues of new fuels, new processes, and especially the possibilities for meeting energy and feedstock needs with integrated processes. In addition to identifying potential energy opportunities, these groups discussed actions necessary to implement the opportunities.

The second discussion topic was designed to address the significant technical questions associated with the energy processes identified in the previous planning efforts. In particular, research needs common to both industries were sought to guide future government research expenditures. This discussion session was also intended to induce development efforts within the industries themselves, via definition of the associated benefits.

1.3 Opportunities Discussion Group Report

The purpose of the Opportunities discussion session was to identify some of the key energy opportunities facing both the chemical and pulp and paper industries and determine one or

more initial actions necessary to exploit these opportunities and achieve more efficient, competitive, and sustainable industrial processes for the two industries. Some of the recommendations from this group include:

- (1) Power production in pulp and paper mills and chemical plants was identified as a major opportunity. There is renewed interest in this area due to restructuring of the electric and natural gas industries and the new opportunities these changes afford for on-site generation and combined heat and power systems.
- (2) There have been recent improvements in power supply and generation technologies such as advanced turbines, fuel cells, and gasifiers and there is interest in identifying opportunities for these technologies on scales (less than 25MW) consistent with industrial applications.
- (3) Co-production and co-processing of fuels, heat, power, and chemicals is another major opportunity. There are significant advantages to developing chemical and pulp and paper facilities that are capable of using a variety of fossil fuel and biomass feedstocks.
- (4) Attracting capital for new energy projects is a significant challenge. Greater innovation is needed to raise funds for demonstration projects and to increase incentives for industry to use more energy-efficient and environmentally-friendly technologies. New policies and regulations that favor such technologies could be very effective, if structured properly.
- (5) In general, there is a need and an opportunity to build a positive image for gasification. Both industries could take advantage of gasification technologies, and there have been improvements in this technology
- (6) Several technology related recommendations came out of the Opportunities discussion groups including: development of improved materials, gas clean-up technologies, and advanced sensor development.

The discussion of actions that would advance these prospects was extensive, identifying many roles for both industry alone and for joint industry/government efforts, and is reported fully within the body of these proceedings.

1.4 Technologies Discussion Group Report

The purpose of the second discussion session was to identify, categorize, and prioritize the most important energy technologies and research, development, and demonstration (RD&D) needs that are common to both the pulp and paper and chemical industries. The group was not to “re-invent the wheel” but to base the discussion on their own experience and expertise and on the background materials presented at this and prior workshops held within their own industry, and crosscut them with the pulp and paper and chemical industries. It was clear that the pulp and paper industry had placed more emphasis on energy issues within its technology vision and RD&D agenda than had the chemical industry. Conversely, the chemical industry is ahead of the pulp and paper industry in actually implementing gasification technologies. Each of these groups produced: (1) a list of technical barriers and constraints to introducing new energy technologies in the two industries; (2) a list of RD&D needs facing the industries, organized into key categories and prioritized by their cross-cutting importance; and (3) a four-cell matrix showing the relative risk and potential payoffs for each of the highest priority RD&D needs.

The highest priority item categorized as high risk *and* high payoff was the development of new and improved materials of construction, particularly those that are high temperature and corrosion-resistant. Of almost equal emphasis in this category was the need for developing combustion processes for handling black liquor and future biomass fuels, especially those with a high nitrogen content. Other high-priority items included: developing gas cleanup technologies, developing coatings and material data at high temperatures for turbines and material handling systems, and developing a turbine that can tolerate dirty gas.

1.5 Where Do We Go From Here?

The Energy Performance Workshop was an initial step to identify common, energy-related technical barriers between the chemical and forest products industries, with the ultimate goal of establishing industrial energy sustainability. The Office of Industrial Technologies will use results from the workshop to support an integrated DOE gasification program. On-going communication with suppliers and industry representatives, including plant visits and technical and programmatic discussions will provide the framework for a strategic plan for an integrated gasification initiative.

Other actions taken that will promote energy sustainability include discussions between OIT and the National Institute of Standards and Technology (NIST) to implement an Internet workshop. This joint effort will leverage government funds to high-risk technologies that industry would not perform on its own. The Internet provides an expeditious mechanism for further discussion and allows participants to suggest approaches to resolve technical barriers presented at the Energy Performance Workshop. More information will be disseminated once this Internet workshop is further developed.

The chemical industry is continuing its vision and planning process, which will help future collaboration between the chemical and pulp and paper industries. Meetings with competitors, suppliers, customers and other key stakeholders are on-going to develop energy technology road maps. Additionally, included in the technical planning process will be a determination of the chemical industry's interest to augment combined cycle cogeneration applications. This workshop provided the forum to determine that there is interest but more work is needed to determine the level of interest. If the chemical industry considers diversity of feed stock, synthesis gas, methanol, and electric power implementation to be a high priority, there will be common goals, as well as challenges, with the pulp and paper industry. Once these technology-planning efforts are complete, another workshop will be considered.

Continued dialogue among industry, government, laboratory, and academe is essential to determine industry needs and where government support will provide the most benefit to the nation. The Industries of the Future strategy focuses on research and development activities that improve resource efficiency and productivity in energy and waste intensive industries. The Forest Products Team and the Chemical Team, two of the eight vision areas, offer industry the opportunity to submit technical proposals through a solicitation process. Results from the workshop will be incorporated into these solicitation processes.

There are many actions that need to be taken to strive for industrial energy sustainability. It is important that we move quickly to advance the efforts begun at the Energy Performance Workshop.



Department of Energy
Washington, DC 20585

June 12, 1998

Dear Colleague:

The Office of Industrial Technologies is hosting an Energy Performance Workshop to discuss important energy issues to the chemical, pulp, and paper industries. The 1 ½ day workshop will take place at the Hyatt Regency, Cincinnati, Ohio on September 1-2, 1998. A registration form and preliminary agenda are enclosed. Please mail or fax registration form by August 10, 1998.

The workshop objectives include: (1) Discuss integration potential for the pulp, paper, and chemical industries between their feedstock streams and power supply needs. (2) Explore more efficient power production technologies. (3) Evaluate gasification and gasification-combined cycle alternatives for a variety of fuels including coal and biomass. (4) Consider the environmental benefits of gasification technologies. (5) Define near-term actions that will help advance the concepts and get industry participation.

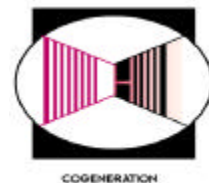
Participants in the workshop include the chemical industry, pulp and paper industry, Gasification Technologies Council, Electric Power research Institute, Department of Energy, and National Institute of Standards and Technology.

We look forward to seeing you at this meeting. Please refer questions regarding this workshop to Shirley North, Workshop Administrator (423-574-8860).

Sincerely,

Patricia Hoffman, Program Manager
Advanced Turbine Systems Program
Office of Industrial Technologies
Energy Efficiency and Renewable Energy

Enclosures (2)



3. AGENDA

**Energy Performance Workshop for the
Chemical and Pulp and Paper Industries, 2000-2020
September 1-2, 1998
Hyatt Regency Cincinnati, Cincinnati, Ohio**

September 1, 1998 (Tuesday)

7:30 Registration and Continental Breakfast

Session I

8:15	Welcome	Denise Swink, Pat Hoffman, <i>Department of Energy</i>
8:30	The challenge of changing the energy paradigm within the Chemical Industry	John Oleson, <i>Dow Corning</i>
8:45	Why the time is NOW for major changes within the Pulp and Paper Industry	Del Raymond, <i>Weyerhaeuser</i>
9:00	Common interests of chemical and pulp and paper industries	Keith Davidson , <i>OnSite Energy</i>
9:20	Advanced Technology Program Overview	Richard Bartholomew, <i>National Institute for Science and Technology</i>
9:40	Office of Utility Technology Biomass Power Program Gasification Activities Overview	Helena Chum, <i>National Renewable Energy Laboratory</i>
10:00	Break	
10:15	Utility Deregulation Opportunities	Richard Scheer, <i>Energetics</i>
10:35	Environmental regulations - the future of output-based standards	Skip Laitner, <i>Environmental Protection Agency</i>
10:55	Panel: Gasification and power service technology options	Douglas M. Todd, <i>General Electric</i> ; Phil Amick, <i>Dynegy Power</i> ; Harry H. Graves, <i>Global Energy</i> ; David Ruprecht, <i>Air Products and Chemicals</i> ; Manuel Quintana, <i>Texaco</i>
12:30	Lunch	

SESSION II-A Chemical Industry Focus

- | | | |
|------|---|---|
| 1:30 | Future electrical/thermal energy needs for the chemical industry | Ammi Amarnath, <i>Electric Power Research Institute</i> |
| 2:00 | Overview of existing chemical industry energy installations | Bruce Hedman, <i>OnSite Energy</i> |
| 2:30 | Co-Production of Transportation Fuels, Chemicals, and Electricity: Program Strategy | Edward Schmetz, <i>Department of Energy</i> |

SESSION II-B Paper Industry Focus

- | | | |
|------|---|--|
| 1:30 | Future electrical/ thermal energy needs for the pulp and paper industry | Ernie Soczka, <i>Electric Power Research Institute</i> |
| 2:00 | Review pulp and paper industry gasification activities | Del Raymond, <i>Weyerhaeuser</i> |
| 2:30 | Battelle Future Energy Resources Corp. gasification process - a status report | Mark Paisley, <i>Battelle Columbus</i> |
| 3:00 | Break | |

SESSION III

- | | | |
|------|-----------------------------|---------------------------------------|
| | | Tom King, <i>Department of Energy</i> |
| 3:15 | Discussion group overviews: | |
| 3:30 | Discussion group breakouts | |
| 5:15 | Adjourn | |
| 5:30 | Reception | |

September 2, 1998 (Wednesday)

- | | | |
|------|-----------------------|--|
| 8:00 | Continental breakfast | |
|------|-----------------------|--|

Session IV

- | | | |
|-------|---|--|
| 8:30 | Case study: Coal gasification with liquid phase methanol technology | Barry Street, <i>Eastman Chemicals</i> ; David Ruprecht, <i>Air Products and Chemicals</i> |
| 9:00 | Discussion groups (continued) | |
| 10:30 | Break | |
| 10:45 | Discussion group reports - planning for the future | |
| 12:00 | Adjourn | |

4. PARTICIPANTS

Name	Organization*	Street Address	City, State, Zip	Phone Number	Fax Number	E-Mail Address
Aidun, Cyrus	IPST	500 10th Street N.W.	Atlanta, GA 30318	404.894.5700	404.894.1496	cyrus.aidun@ipst.edu
Ali, Sy	Allison Engine Co.	PO Box 420, MSW16	Indianapolis, IN 46206.0420	317.230.6864	317.230.5600	
Amick, Phil	Dynegy Power Corp.	1000 Louisiana, Ste. 5800	Houston, TX 77002	713.767.8667	713.767.8515	pram@dynegy.com
Amarnath, K. R.	EPRI	PO Box 10412, 3412 Hillview Ave.	Palo Alto, CA 94304.1395	650.855.2548		aamarnat@epri.com
Anson, Don	Battelle	505 King Avenue	Columbus, OH 43301	614.424.5823	614.424.3321	
Ayala, Varin	Air Products and Chemicals, Inc.	7201 Hamilton Blvd.	Allentown, PA 18195	610.481.4145	610.481.2576	ayalav@apci.com
Badin, Joseph	Energetics, Inc.	7164 Gateway Drive	Columbia, MD 21046	410.290.0370	410.290.0377	jbadin@hotmail.com
Balthaser, Rick	DOE	PO Box 5400	Albuquerque, NM 87185.5400	505.845.4466	505.845.4430	rbalthaser@doeal.gov
Bartholomew, Richard	NIST	Bld 101, Rm A225	Gaithersburg, MD 20899	301.975.4786	301.548.1087	richard.bartholomew@nist.gov
Beasley, Cloyd	ORNL	PO Box 2008, MS.6359	Oak Ridge, TN 37831.6359	423.576.3913	423.576.5231	beasleycojr@ornl.gov
Brinch, Jeannette	Energetics, Inc.	7164 Gateway Drive	Columbia, MD 21046	410.290.0370	410.290.0377	enesupg@lx.netcom.com
Cardwell, Norma	ORNL	PO Box 2008, MS.6429	Oak Ridge, TN 37831.6429	423.574.5979	423.574.5738	cardwellnf@ornl.gov
Childress, James	Gasification Technologies Council	1110 N. Glebe Rd. Ste 610	Arlington, VA 22201	703.276.0110	703.276.7662	jchildress@kchihq.com
Chum, Helena	NREL	MS 1613, 1617 Cole Blvd.	Golden, CO 80401	303.275.2949	303.275.2905	Helena_Chum@nrel.gov
Ciesar, James	Siemens Westinghouse Power Corp.	1310 Beulah Rd.	Pittsburgh, PA 15235	412.256.2564	412.256.1867	ciesarja@westinghouse.com
Davidson, Keith	Onsite.Sycom	701 Palomar Airport Rd.	Carlsbad, CA 92009	760.931.2400	760.931.2405	kdavidson@onsiteenergy.com
DeCarrera, Robert	Georgia.Pacific Corp.	PO Box 105605	Atlanta, GA 30348.5605	404.652.4686	404.654.4746	rdecarre@gapac.com
Fong, Craig	LBNL	One Cyclotron Rd.	Berkeley, CA 94720	510.486.5298	510.486.7678	cgfong@lbl.gov
Geliske, Terry	MELE Associates DOE	Crystal Gateway North, 1111 Jefferson Davis Hwy.	Arlington, VA 22202	703.412.2706	703.412.2707	
Gorog, Peter	Weyerhaeuser					

Name	Organization*	Street Address	City, State, Zip	Phone Number	Fax Number	E-Mail Address
Graves, Harry	Global Energy	1500 Chiquitta Center, 250 E. 5th Street	Cincinnati, OH 45202	513.621.0077		
Hedman, Bruce	Onsite.Sycom	1010 Wisconsin Ave., NW, # 340	Washington, DC 20007	202.625.4119	202.625.1067	bhedman@ onsiteenergy.com
Hensel, Bob	GTS Duratek	6 Stone Ridge Drive	Barrington, IL 60010	847.304.9646	847.304.5889	bobhensel@ earthlink.net
Hoffman, Christina	ORNL					
Hoffman, Patricia	DOE	1000 Independence Ave., SW	Washington, DC 20585.0121	202.586.6074	202.586.1658	patricia.hoffman@ ee.doe.gov
Howells, Lawford	Foster Wheeler International Corp.	Perryville Corporate Park	Clinton, NJ 08809	908.730.4499	908.730.5292	lawford_howells@ fwc.com
Humphreys, Penny	ORNL	PO Box 2008, MS.6065	Oak Ridge, TN 37831.6065	423.574.4347	423.241.0411	humphreyspm@ ornl.gov
Huyuh, David	DOE					
Jasper, Steven	Dow Chemical Co.	2301 N. Brazosport Blvd B101	Freeport, TX 77541.3257	409.238.4951	409.238.0284	sjasper@dow.com
Jones, Alan	Union Camp Corp.	PO Box 2310	Savannah, GA 31402	912.965.6014	912.965.6110	
Jones, Andrew	International Paper	PO Box 7910	Loveland, OH 45140.7910			
Karnitz, Mike	ORNL	PO Box 2008, MS.6065	Oak Ridge, TN 37831.6065	423.574.5150	423.241.0411	karnitzma@ornl.gov
Keiser, Jim	ORNL	PO Box 2008, MS.6156	Oak Ridge, TN 37831.6156	423.574.4453	423.574.5118	keiserjr@ornl.gov
Kenchington, Hank	DOE	1000 Independence Ave., SW	Washington, DC 20007	202.586.1878	202.586.6507	henry.kenchington@ hq.doe.gov
King, Thomas	DOE	1000 Independence Ave., SW	Washington, DC 20585.0121	202.586.2387	202.586.1658	tom.king@ee.doe.gov
Kirschner, Mark	BOC Group Technical Center	100 Mountain Ave	Murray Hill, NJ 07974	908.771.6423	908.771.6113	mark.kirschner@ us.gtc.boc.com
Knoll, Andy	Champion International Corporation	PO Box 87, 375 Muscogee Rd.	Cantonment, FL 32533	850.937.4873	850.968.3077	knolla@ champint.com
Kowalczyk, Irene	Westvaco Corp.	299 Park Ave.	New York, NY 10171	212.318.5460	212.318.5470	iakowal@ westvaco.com
Laitner, John A.	EPA Office of Atmospheric Programs	501 3rd Street NW, 4th Floor, MS 6201.J		202.564.9833	202.565.2147	laitner.skip@epa.gov
Lockwood Dwight	Global Energy					
Lynch, George	DOE			301.903.9434		george.lync@ hq.doe.gov

Name	Organization*	Street Address	City, State, Zip	Phone Number	Fax Number	E-Mail Address
Mahajan, Kanwal	DOE.FETC	3610 Collins Ferry Rd., PO Box 880	Morgantown, WV 26505	304.285.4965	304.285.4403	kmahaj@fetc.doe.gov
Mansour, Amal	MTCI, Inc.	6001 Chemical Rd.	Baltimore, MD 21226	410.354.0420	410.354.0471	mtcihqtr@aol.com
Mansour, Momtaz	ThermoChem Inc.	6001 Chemical Rd.	Baltimore, MD 21226	410.354.9890	410.354.9894	tcheminc@aol.com
Menville, Ron L. Jr.	Brightstar Synfuels Co.	PO Box 539	St. Gabriel, LA 70776	225.642.2500	225.642.2503	ronmenvillejr@ worldnet.att.net
Miner, Reid	National Council of the Paper Industry for Air & Stream Improvement	PO Box 13318	Research Triangle Park, NC 27709	919.558.1991	919.558.1998	rainer@ucasi.org
Morehead, Harry	Westinghouse Power Generation	4400 Alafnya Trail	Orlando, FL 32826	407.281.3322	407.281.5014	moreheht@notes. westinghouse.com
Ohl, Mike	Georgia.Pacific Corp.	Rte 501	Big Island, VA 24526	804.299.5911	804.299.6149	mdohl@gapac.com
Oleson, John	Dow Corning	PO Box 994, Mail #CO1330	Midland, MI 48686.0994	517.496.4516	517.496.6942	usdcc2fc@ ibmmail.com
Olszewski, Mitch	ORNL	PO Box 2009, MS.8038	Oak Ridge, TN 37831.8038	423.574.0770	423.576.0493	olszewskim@ornl.gov
Paisley, Mark	Battelle	505 King Avenue	Columbus, OH 43201.2693	614.424.4958	614.424.3321	paisley@battelle.org
Pelfrey, Don	Kentucky Industrial Utility Customers	36 E. 7th St., Suite 2110	Cincinnati, OH 45202	513.421.2255	513.421.2764	
Quintana, Manuel	Texaco Inc.	4800 Fournace Place	Baellaire, TX 77401	713.432.3099	713.432.6985	quintme@texaco.com
Randall, Paul	U.S. EPA	26 W. Martin Luther King Dr.	Cincinnati, OH 45268	513.569.7673	513.569.7677	randall.paul@ epamail.epa.gov
Raptis, Paul	ANL	9700 S. Cass Avenue	Argonne, IL 60439	630.252.5930	630.252.3250	raptis@anl.gov
Raymond, Del	Weyerhaeuser	Mailstop CCII-103	Federal Way, WA 98477-0001	253.924.6850	253.924.6812	raymond@wdni.com
Rice, Steven	SNL	7011 East Avenue	Livermore, CA 94551.0969	925.294.1353	925.294.2276	sfrice@sandia.gov
Robinson, Valri	DOE	1000 Independence Ave., SW	Washington, DC 20585	202.586.0937	202.586.3237	valri.robinson@ ee.doe.gov
Rollins, Martha	Tennessee Valley Authority	1101 Market Street MR2T		423.751.4712	423.751.2463	mlrollins@tva.gov
Ruprecht, David	Air Products & Chemicals, Inc.	7201 Hamilton Blvd.	Arlington, PA 18195	610.481.8149	610.481.6670	ruprecdr@apc.com

Name	Organization*	Street Address	City, State, Zip	Phone Number	Fax Number	E-Mail Address
Scheer, Richard	Energetics, Inc.	501 School St., Suite 500	Washington, DC 20024	202.479.2748	202.479.0229	rscheer@ energeticsinc.com
Schmetz, Edward	DOE	FE.24 GTN	Germantown, MN 20874	301.903.3931	301.903.2238	edward.schmetz@ hg.doe.gov
Schmidt, Anton	EnergyWorks USA	PO Box 248	Albany, OR 97321	541.967.6129	541.967.6140	aschmidt@portland. energyworks.com
Schweitzer, Martin	ORNL	PO Box 2008, MS.6206	Oak Ridge, TN 37831.6206	423.576.2726	423.576.6661	schweizerm@ ornl.gov
Shaddix, Christopher	SNL	MS 9052, 7011 E. Ave.	Livermore, CA 94551.0969	925.294.3840	925.294.2276	crshadd@sandia.gov
Smeenk, Jerod	Center for Coal and the Environment	1043 Black Engr., Iowa State University	Ames, IA 50011	515.294.6402	515.294.3261	jsmeenk@iastate.edu
Smith, Al	Rock.Tenn Company	504 Thrasher St.	Norcross, GA 30071	770.448.2193	770.263.4465	asmith@rockteen.com
Smith, Merrill	DOE	1000 Independence Ave., SW	Washington, DC 20585	202.586.3646	202.586.1658	merrill.smith@ ee.doe.gov
Soczka, Ernest	EPRI	500 10th Street NW	Atlanta, GA 30318	404..894.664 2	404.894.6429	ernie.suczka@ipst.ed u
Stiegel, Gary	DOE	PO Box 10940	Pittsburgh, PA 15236	412.892.4499	412.892.4822	stiegel@fetc.doe.gov
Stovall, Therese	ORNL	PO Box 2008, MS.6092	Oak Ridge, TN 37831.6092	423.574.0329	423.576.3894	stovalltk@ornl.gov
Street, Barry	Eastman Chemical Co.	PO Box 54	Kingsport, TN 37662	423.229.6062	423.224.7268	btstreet@ eastman.com
Swanson, Mike	University of North Dakota					
Swindeman, Bob	ORNL	PO Box 2008, MS.6155	Oak Ridge, TN 37831.6155	423.574.5108	423.574.5118	swindemanrw@ ornl.gov
Swink, Denise	DOE	FORS Bldg., 5F.065, EE.20	Washington, DC 20585	202.586.9232	202.586.9234	denise.swink@ ee.doe.gov
Thijssen, Johannes	Arthur D. Little, Inc.	20 Acron Park		617.498.6084	617.498.7054	thijssen.j@ adlittle.com
Todd, Douglas	General Electric	1 River Rd., Bldg. 2.720	Schenectady, NY 12345	518.385.3791	518.385.2590	douglas.todd@ ps.ge.com
Tucker, Paul	International Paper	6285 Tri.Ridge Blvd.	Loveland, OH 45140	513.248.6790	513.248.6679	paul.tucker@ ipaper.com
Vick, Steve	Global Energy					
Walters, Richard	Albany Research Center	1450 Queen Ave. SW	Albany, OR 97321	541.967.5873	541.967.5991	walters@alrc.doe.gov
Watson, Ingrid	DOE	1000 Independence Ave., SW	Washington, DC 20585.0121	202.586.8119	202.586.1658	ingrid.watson@ ee.doe.gov
Weiner, Steven	PNNL	901 D Street SW, Suite 900	Washington, DC 20024.2115	202.646.7870	202.646.5020	sc.weiner@pnl.gov

Name	Organization*	Street Address	City, State, Zip	Phone Number	Fax Number	E-Mail Address
Wessel, James	Consultant, ORNL	127 Westview	Oak Ridge, TN 37830	423.482.4145		zcb140a@prodigy.com
Widrig, Chris	CIETP	505 King Avenue	Columbus, OH 43201	614.424.4724	614.424.4725	
Williams, Jennifer	Global Energy	312 Walnut Street	Cincinnati, OH 45202	513.621.0077		jhw@globalenergyinc.com
Winslow, John	DOE.FETC	PO Box 10940	Pittsburgh, PA 15236	412.892.6272	412.892.4822	winslow@fetc.doe.gov
Wright, Thomas	Consultant	325 Axton Drive	Knoxville, TN 37922	423.966.9553		tlwright@conc.tds.net
Yagiela, Anthony	McDermott Technology, Inc.	1562 Beeson Street	Alliance, OH 44601	330.829.7403	330.829.7801	anthony.s.yagiela@mcdermott.com
Yang, Wenrui	Union Camp Corp.	3401 Princeton Pike	Lawrenceville, NJ 08648	609.844.7447	609.732.9150	wenrui_yang@ucamp.com

*ANL - Argonne National Laboratory, CIETP - Chemical Industry Environmental Technology Projects, DOE - U.S. Department of Energy, EPRI - Electric Power Research Institute, LBNL - Lawrence Berkeley National Laboratory, NIST - National Institute for Science and Technology, NREL - National Renewable Energy Laboratory, ORNL - Oak Ridge National Laboratory, PNNL - Pacific Northwest National Laboratory, SNL - Sandia National Lab

5. DISCUSSION GROUPS

5.1 Organization and Goals

The purpose of the discussion groups was twofold: first, to identify research and commercialization opportunities for energy self-sufficiency in the chemical and pulp and paper industries; and second, to determine research, development, and demonstration opportunities and areas of mutual interest within the two industries for energy technology development, including demonstration projects.

Workshop participants were divided into four, equally balanced groups of 15-20, representing members of the pulp and paper, chemical, electric power and fuels industries, national laboratories, trade associations, universities, consultants, DOE, and EPA. Two of the four groups discussed Energy Opportunities, and the other two groups discussed Energy Technology Needs. During the three hours that each of the four groups met, professional facilitators from Energetics, Incorporated, and Oak Ridge National Laboratory led discussions which resulted in a set of priorities and action items for both the federal government and the two industries.

The purpose of the Energy Opportunities discussion sessions was to identify some of the key energy opportunities facing both the chemical and pulp and paper industries, and determine one or more initial actions necessary to exploit these opportunities and achieve more efficient, competitive, and sustainable industrial processes for the two industries.

The purpose of the Energy Technology Needs discussion sessions was to identify, categorize, and prioritize the most important energy technologies and RD&D needs that are common to both the pulp and paper and chemical industries. These groups were not to “re-invent the wheel” but to base their discussions on their own experience and expertise and on the background materials presented at this workshop. Group members were also to use the results of many prior workshop discussions held within their own industries and crosscut them with the pulp and paper and chemical industries. These groups were challenged with three focus questions:

- (1) What are the most significant technical barriers, constraints, problems, or issues in developing and implementing advanced energy technologies in your industry? This discussion of barriers was used to stimulate participants’ thinking about the current state of affairs in the chemical and pulp and paper industries and to provide a starting point for the subsequent group discussion of RD&D needs.
- (2) What are the most important crosscutting energy RD&D needs which should be pursued to overcome identified technical barriers or constraints?
- (3) What are the expected technical risks and financial payoffs for investments in top priority RD&D needs? For this discussion, the appropriate meaning of the key terms were defined as: *Risk* consists of technical and economic barriers to deployment, and *Payoff* consists of economic and environmental payoffs to industry.

The information which follows represents the results of each of the discussion groups.

5.2 Discussion Group 1A (Red) - Energy Opportunities

Participants in the “Red Group” are listed in Exhibit 1.

Identify Energy Opportunities

A summary of the notes taken during the discussion of energy opportunities can be found in Exhibit 2. Following are the key points made during the discussion.

Power production in pulp and paper mills and chemical plants is a major opportunity. There is renewed interest in this area due to restructuring of the electric and natural gas industries and the new opportunities these changes afford for on-site generation and combined heat and power systems. There have been recent improvements in power supply and generation technologies such as advanced turbines, fuel cells, and gasifiers and there is interest in identifying opportunities for these technologies on scales (less than 25MW) consistent with industrial applications. For gasification technologies to be most effective, there is a need to develop techniques that can clean gas streams to specified levels before the gases reach the turbine blades.

Coproduction and coprocessing of fuels, heat, power, and chemicals is another major opportunity. There are significant advantages to developing chemical and pulp and paper facilities that are capable of using a variety of fossil fuel and biomass feedstocks. Existing waste streams in chemical plants and pulp and paper mills have energy and chemical value that could be extracted if cost effective processing technologies were available.

There are opportunities for using energy more efficiently in existing manufacturing processes. For example, paper drying is an energy-intensive process that offers thermal efficiency improvement potential if ways could be found to capture and use the waste heat. There are also opportunities to capture the energy value in low temperature waste streams in chemical plants and pulp and paper mills. Low energy bleaching chemicals need to be found for paper making.

Biomass energy systems are another opportunity for both the chemical and pulp and paper industries. To exploit biomass resources more effectively, crop yields need to increase and the

Exhibit 1 **Discussion Session Participants** **Energy Opportunities** **1A - “Red Group”**

Name	Organization
Keith Davidson	Onsite Sycom
Lawford Howells	Foster Wheeler
Patricia Hoffman	U.S. Department of Energy
Andy Jones	International Paper
Al Jones	Union Camp
Hank Kenchington	U.S. Department of Energy
Andy Knoll	Champion International
Dwight Lockwood	Global Energy
George Lynch	U.S. Department of Energy
Ron Menville	Brighton Synfuels
John Oleson	Dow Corning
Mark Paisley	Battelle
Don Pelfrey	Kentucky Industrial Utility Customers
Steve Rice	Sandia National Laboratory
Martha Rollins	Tennessee Valley Authority
Ed Schmetz	U.S. Department of Energy
Jerod Smeenk	Iowa State University
Al Smith	Rock-Tenn
Barry Street	Eastman Chemical
Jan Thijssen	Arthur D. Little

Facilitator: *Rich Scheer, Energetics*

Note Taker: *Mitch Olszlwski, ORNL*

cost of biomass fuels needs to decrease. The improvement of feedstock drying methods is a key opportunity.

Adopting a broader systems perspective could be effective in uncovering major untapped opportunities. Systems like combined-cycle-cogeneration are commercially available but have multiple benefits that are not often recognized when manufacturing systems are viewed in isolation. Municipal solid wastes could be utilized to an even greater extent. Partnerships between industry and government, and between industries and utilities, need to be pursued, particularly for overcoming hurdles associated with using new technologies.

Attracting capital for new energy projects is a significant challenge. Greater innovation is needed to raise funds for demonstration projects and to increase incentives for industry to use more energy-efficient and environmentally-friendly technologies. New policies and regulations that favor such technologies could be very effective, if structured properly. Tax breaks, for example, for using energy efficient technologies often are more effective in getting the attention of top management than are direct financial subsidies. Better integration of energy, environmental, agricultural, and resource policies could also help in removing barriers and spurring innovation. Output-based standards for emissions could be useful in providing incentives for industry to recognize the environmental benefits of technologies such as combined heat and power systems. There is a general need to provide information and education on the costs and benefits of various technologies to key industry decision makers and federal and state policy officials.

Activities/Actions

A summary of notes taken during the discussion of actions can be found in Exhibit 3. Following are the key points raised during the discussion.

Among the initial steps needed to move forward is the development and dissemination of fact-based assessments that quantify where opportunities lie. Gas clean-up in turbine-based systems, for example, is an important opportunity but there is a need for an assessment that determines how clean the gas streams need to be, from both technical and regulatory perspectives. Such an assessment needs to cover all sizes of turbines, in a variety of industrial applications, using both fossil and biomass fuels.

On-site generation using smaller turbines in chemical plants is another important opportunity. What is needed now are plant-level feasibility studies that show where the opportunities lie for cost savings and revenue generation. Such studies could be accomplished as one part of subsequent roadmapping efforts currently being planned by the chemical industry. Also needed are stronger outreach and marketing efforts to package and disseminate objective information on the relative merits of different turbine products and generation sets that are already commercially available. An assessment also needs to be done to determine the opportunities for fuels cells in the chemical and pulp and paper industries.

Executive decision makers in both the chemical and pulp and paper industries are not focused on opportunities as far as the energy aspects of their businesses. Competitive pressures for cost cutting and financial performance of core businesses are more important areas of concern. Effort is needed to raise awareness among senior executives in the industries of the profit-making opportunities from investments in on-site power, combined heat and power, coprocessing, and coproduction technologies. To foster use of private capital in energy demonstrations, the government could sponsor an “executive dialog” on innovative financing arrangements and government industry partnerships. Such a meeting could discuss the need for new tax policies or

procurement reforms to reduce the risks and raise the incentives for industry to target investments in energy RD&D projects.

“Red Group,”

(♦ = Most Important Opportunities)

[illegible]

Exhibit 2 (cont.)

Energy Opportunities

Discussion Group Results

“Red Group”

(♦ = Most Important Opportunities)

Power Production		Processing	Systems and Strategies	Regulations and Policies		
Higher temperature and pressure cycles on existing equipment		Increase the percentage of solids feeding black liquor	Unified utility-pulp and paper strategy so that fiber and energy crops can co-exist ♦	Encourage state and local decision making (not federal)		
Combustion optimization - Including better combustion monitoring technologies		Alternatives to the Kraft method for pulping	Unified strategy for using all viable fuels forms for co-production of fuels, chemicals, and power ♦	Remove politics from the global warming debate		
Lower efficiency power conversion equipment for use with cheap, dirty feedstocks		Improve shift technologies to improve syngas	Municipal solid waste handling to make materials more amenable to processing and less likely to end up in land fills ♦			
Competitive alternative fuels to natural gas			Include electric power planning in chemical and pulp and paper roadmaps			
			Diversify chemical industry feedstocks to increase use of coal			
			Industry-wide strategies for adopting energy efficiency and clean technologies without government mandates			

Exhibit 3
Activities/Actions
“Red Group”

Power Production — Gas Clean-Up Before the Turbine	Power Production — Smaller Gas Turbines	Economics and Financing — Innovative Capital Finance Tools	Co-production and Co-processing — Integrate Chemical and Power Production	Power Production — Fuel Cells
<p>This is a critical enabling technology for all gasification requirements</p> <p>Cover more applications than power production, also chemicals and thermal energy</p> <p>Systems need to have a low energy penalty and be simple to minimize downtime and O&M expenses</p> <p>Must also have low capital and operating costs</p> <p>The systems cannot create additional by-products that can't be re-used and are difficult to dispose of</p> <p>Further definition of what constitutes “clean” is needed</p> <p>ACTION: Conduct a broad-based needs assessment to determine what “clean” means</p> <ul style="list-style-type: none"> - Covers all sizes of turbines in all applications and biomass and fossil feedstocks - Includes a baseline of where gas clean-up is today, and where it needs to go - Would a collaborative effort of government and 	<p>Much government and industry RD&D is on-going</p> <p>Systems needed for pulp and paper, biomass power, and on-site generation in chemical plants</p> <p>Systems also needed for utility distributed power applications</p> <p>Includes micro-turbine systems</p> <p>Greater awareness of the relative merits of existing equipment is needed</p> <p>ACTION: Conduct plant-level assessments in the chemical industry</p> <ul style="list-style-type: none"> -Plant-specific follow-up to industry wide studies -Part of chemical industry roadmap processes <p>ACTION: Get the word out about existing equipment</p>	<p>Tax breaks often more effective than direct subsidies</p> <p>Streamlined permitting also an important inducement</p> <p>50/50 cost share may not always be the proper mix</p> <p>Use of government funds requires broad-based industry support</p> <p>Barriers exist for the chemical industry in working with utilities on joint ventures and financing</p> <p>Pulp and paper industry faces severe capital constraints</p> <p>ACTION: Convene an “executive dialog” of industry decision makers</p> <ul style="list-style-type: none"> -Discuss financing needs, innovative capital raising techniques, new policy options <p>ACTION: Review federal RD&D procurement regulations</p> <ul style="list-style-type: none"> -Redesign to increase attractiveness to industry -Create more incentives for industry participation -Reduce risks to industry — technical 	<p>Includes biomass and fossil feedstocks</p> <p>Recognize the limits to integration - inflexibility, availability, complexity</p> <p>Potential is large but the value of carbon dioxide reductions is uncertain</p> <p>ACTION: Educate chemical industry executives on profitability of co-production</p>	<p>Many of RD&D activities are on-going</p> <p>The potential is over the long term, not a near term solution</p> <p>Need for waste heat recovery systems</p> <p>Relative merits of alternative feedstocks not understood</p> <p>ACTION: Conduct assessment to identify fuel cell applications in pulp and paper and chemical industries</p> <p>ACTION: Compile and disseminate information on the relative merits of existing equipment to key decision makers in the chemical and pulp and paper industries</p>

5.3 Discussion Group 1B (Blue) - Energy Opportunities

Participants in the “Blue Group” are listed in Exhibit 4.

Identify Energy Opportunities

A summary of the notes taken during discussion of energy opportunities may be found in Exhibit 5. Following are the key points made during the discussion.

Development of improved materials for boiler tubes, construction, and other manufacturing elements of both the chemical and pulp and paper industries presents an important opportunity for energy efficiency and use of on-site generation of energy.

Improvements such as the use of ceramic materials to combat corrosion in the chemical industry could improve both the environmental and energy problems with water use in the pulp and paper and chemical industries.

Gas clean-up technologies are another high priority for improvements in these industries. There is a need to develop techniques that can clean gas streams to specified levels before gases reach the turbine blades. Related to this opportunity, opportunities exist for improvements in turbine technology, to make them operate more efficiently.

Advanced sensor development in harsh conditions is a key opportunity for both industries. Sensors are used extensively in industrial settings; improvements in efficiency, reliability, sensitivity, etc. could have important down-stream effects on energy use in both industries.

Opportunities for outsourcing energy efficiency and generation of energy for on-site use are available and should be exploited. Energy is not the business of pulp and paper and chemical companies; energy allows these industries to produce materials, but energy expertise is not always available in-house. Outsourcing represents a cost-effective opportunity for making improvements efficiently and more inexpensively than might otherwise be achieved and should be recommended.

Utilizing cogeneration technologies is another cost-effective opportunity for both industries. There is renewed interest in cogeneration due to electric utility restructuring and both industries could take advantage of on-site generation and combined heat and power systems. By working cooperatively with Congress to insure opportunities for cogeneration, both industries believe that this opportunity could be better realized.

In a similar vein, there are opportunities for chemical and pulp and paper plants to install new technologies that have the potential to save energy and use renewable energy/cogeneration systems, but put the plants at risk of not meeting specified DOE or EPA regulations for efficiency

Exhibit 4 **Discussion Session Participants** **Energy Technology Needs** **1B - “Blue Group”**

Name	Organization
Valri Robinson	DOE-OIT
Terry Gelishe	Mele Associates
Anton Schmidt	Energy Works USA
Tom Wricht	Consultant
Helena Chum	NREL
Mike Karnitz	ORNL
Harry Graves	Global Energy
Wenrui Yang	Union Camp Corp.
Manuel Quintana	Texaco
Tom King	DOE-OIT
Peter Gorog	Weyerhaeuser Co.
Jim Keiser	ORNL
Christina	ORNL
Hoffmann	PNNL (Washington, DC)
Steven C. Weiner	

Facilitator: Jan Brinch, *Energetics*

Note Taker: Helena Chum, *NREL*

or environmental cleanliness. One example of this is the environmental restrictions on incineration, which have an impact on cogeneration opportunities. Flexibility in meeting these regulations is an opportunity for plants to install systems and monitor them without risking noncompliance.

In general, there is a need and an opportunity to build a positive image for gasification. Both industries could take advantage of gasification technologies, and there have been improvements in this technology. Enhancing more widespread use of gasification is an opportunity which should be pursued, through education of corporate policy makers and financial institutions, transferring information and technologies among industries, holding conferences and workshops, and generally fostering improved communication about gasification.

Activities/Actions

A summary of the notes taken during the discussion of activities and actions can be found in Exhibit 6. Following are the key points raised during the discussion.

The initial step to be taken in materials development is identification of best practices in the chemical, pulp and paper, and glass industries on refractory materials and metals (chromium disposal issues were also discussed). Research and development should be conducted on these material issues. The next step is to develop reports and/or papers on these materials and to share them with others in the pulp and paper, chemical, and glass industries. These actions should be jointly undertaken by government, specifically DOE, working cooperatively with industry.

In the area of gas clean-up, alkali removal is a critical technological issue which needs to be addressed. Both materials and removal options need to be identified. Actions to be taken include identification of activities, reports, and workshops on gas clean-up technologies related to removing alkali from gas, and identifying other industries where gas clean-up technologies have proven effective. This should be a joint government-industry effort.

As stated earlier, energy supply and efficiency are not the main business of chemical and pulp and paper industries. They can not always be handled in-house, due to lack of expertise and time/materials. Outsourcing is one way to design and implement energy efficiency opportunities and to take advantage of new energy technologies, including generation of energy on-site. Case studies should be conducted on industries that have used outsourcing to create “power islands” in the chemical and pulp and paper industries; such studies should then be disseminated to industry decision-makers. Trade associations representing these two industries should take the lead in conducting these case studies.

The chemical and pulp and paper industries should build consensus with Congress and others through their trade organizations on potential incentives which would create enhanced opportunities for more efficient energy technologies and secure energy supplies. Incentives, such as Sec. 29 loans and equity grants, would encourage energy opportunities in the two industries.

As noted above, the chemical and pulp and paper industries need some regulatory flexibility to prove the technical worthiness of certain new energy installations. Both DOE and EPA should work cooperatively with industries to allow flexibility when the first few commercial technologies and plants are designed and built.

And finally, a positive image needs to be developed for gasification to educate the public on clean gas technologies. The Gas Technology Council, in cooperation with other industry trade associations, should initiate a “Clean Gas Campaign” to inform and educate the public on gasification.

Exhibit 5
Results Energy Opportunities
Discussion Group Results
“Blue Group”

(◆ = Most Important Opportunities)

Technologies	Business Strategies	Regulatory Compliance Strategies	Public Policies	Information and Education
Advanced sensor development in harsh conditions ◆◆◆◆◆	Energy business units outsourcing (IGCC) ◆◆◆	Regulatory flexibility for new installations ◆◆◆◆◆	Provide incentives (e.g., Section 29, loan support, equity grants) ◆◆	Build a positive image for gasification ◆◆◆◆◆◆◆
Turbine technology issues ◆◆◆	Pool funding resources and information to address gasification technical issue ◆◆	Opportunity to go beyond compliance	Should not do demos but commercial projects ◆◆	Educate corporate policy markets to change present strategic paradigm (don't understand new technologies) ◆◆
Pollution prevention/waste minimization with new technology ◆	Tipping fee for productive use ◆	Tax emissions	Valley of Death (R&D tax credits, municipal bonds)	Make financial institutions familiar with new technologies ◆
Improve motor efficiency within pulp and paper and chemical industries	Deregulation will create opportunities for pulp & paper and chemical industries to become energy producers ◆	Environmental restrictions on incineration		Information transfer between chemical and paper industries ◆
Product quality from gasification	Synergistic opportunities in local areas to create new products ◆◆	Utility deregulation opportunities will increase distributed generation		Joint conferences, workshops on common interests
Improve drying - any synergisms to decrease energy in two industries?	Good info from EPC contractors (cost, etc.)			Information sharing among plants to advance genomic users and tree developers
Balance of plant issues	On-site generation of electricity for multiple feeds with other products ◆			Develop value-added products (not currently produced), such as a data base or information system
Materials development (boiler tubes, construction, etc.) ◆◆◆◆◆◆◆◆◆◆	Secondary product development/opportunities with gasification ◆			Educate regulators
Gas clean-up technologies ◆◆◆◆◆◆◆				Information sharing among universities to develop new curricular in support of new technologies
Integrate power generation with paper making process (thermal) ◆				

Exhibit 5
Results Energy Opportunities
Discussion Group Results
“Blue Group”

(◆ = Most Important Opportunities)

Technologies	Business Strategies	Regulatory Compliance Strategies	Public Policies	Information and Education
<p>Transfer knowledge about technologies, e.g., solid waste recovery, from chemical industry to pulp and paper industry ◆</p> <p>Identify appropriate distributed manufacturing opportunities from waste streams (i.e., from pulp & paper) ◆</p> <p>Advanced controls research for both industries</p> <p>Heat exchanger and evaporator technology improvements</p> <p>Identify common separation technologies</p>	<p>Additional conventional cogeneration ◆◆◆</p> <p>Industrial consortia to drive technologies to market ◆◆</p> <p>Improve plant environment and economics with one technical investment, e.g., gasification ◆◆</p> <p>Active role with Congress by industry on needs ◆◆◆</p> <p>Warrantees/ guarantees on new technologies/ energy performance contracting</p> <p>Decide goals near term \$ for future value/sustainability of industry</p> <p>Window of opportunity - boiler capital replacement is short</p>			

Exhibit 6
Activities/Actions “Blue Group”

Materials Development	Gas Clean-Up Technologies	Business Strategies	Public Policies	Regulatory Compliance Strategies	Information and Education
<i>Activities</i>					
<p>This is an opportunity for joint activity in the chemical and pulp and paper industries</p> <p>Refractory materials and metals are key targets of opportunity</p> <p>Need to identify best practices in both chemical and pulp and paper, as well as glass industries</p> <p>Chromium issues for disposal of refractories, as well as chromium-free materials needs to be developed</p> <p>Refractory materials for black liquor, which are low cost and have a long life, need to be developed</p>	<p>Alkali removal is a critical technological issue which needs to be addressed</p> <p>Both materials and activities should be identified</p>	<p>Energy is not the main business of chemical and pulp and paper industries</p> <p>Energy supply and conservation opportunities cannot always be handled in-house, due to lack of expertise and time/materials</p> <p>Outsourcing expertise and activities to improve efficiency and assure adequate supplies is an appropriate activity for the two industries</p>	<p>Incentives should be provided (such as Sec. 29, loans, equity grants) to encourage energy efficiency opportunities in the two industries</p> <p>Industry should take an active role with Congress to develop public policies which will positively impact industry needs</p>	<p>Chemical and pulp and paper industries need regulatory flexibility to prove the worthiness of new technical installations</p> <p>DOE and EPA should work cooperatively with industry to identify a framework for flexibility when the first, few commercial technologies and plants are designed and built</p> <p>DOE and EPA requirements sometimes stand in the way of industry efforts to design and build new plants, or try new technologies</p>	<p>A positive image needs to be developed for gasification to educate the public on clean gas technologies</p> <p>Education and promotion of clean gas technologies should be accomplished</p>

Exhibit 6
Activities/Actions “Blue Group”

Materials Development	Gas Clean-Up Technologies	Business Strategies	Public Policies	Regulatory Compliance Strategies	Information and Education
<i>Actions</i>					
<ul style="list-style-type: none"> -Identify best practices across the chemical, pulp and paper, and glass industries on refractory materials, metals, and chromium issues -Conduct research and development on refractory materials and metals for black liquor -Develop reports and/or papers on materials issues identified above, and share them with others in the pulp and paper, chemical, and glass industries -These actions should be jointly undertaken by government, specifically DOE, and industry 	<ul style="list-style-type: none"> -Identify activities, reports and workshops on gas clean-up technologies related to removing alkali from gas -Identify other industries where gas clean-up technologies have proven effective -This should be a joint government/industry effort 	<ul style="list-style-type: none"> -Conduct case studies on industries that have used outsourcing to create “power islands” in the chemical or pulp and paper industries -Disseminate the case study write-ups to industry decision-makers -Trade associations should take the lead in conducting the case studies 	<ul style="list-style-type: none"> The chemical and pulp and paper industries should build consensus, through their trade organizations, on potential incentives which would create enhanced opportunities for more efficient energy technologies and renewable, secure energy supplies for their two industries 	<ul style="list-style-type: none"> Trade associations, working cooperatively with the industries and government, should take the lead in working with regulatory agencies when new technologies and plants are tried. Environ-mental and energy efficiency targets possibly need to be relaxed to allow pilot, or new plants to use new technologies 	<ul style="list-style-type: none"> The Gas Technology Council, in cooperation with other industry trade associations, should initiate a “Clean Gas Campaign” to inform and educate the public on gasification

5.4 Discussion Group 2A (Yellow) - Energy Technology Needs

Members of the “Yellow Group” are listed in Exhibit 7. They represented the pulp and paper and chemical industries, federal agencies, several research laboratories and universities, and energy-related vending and consulting firms.

Technical Barriers and Constraints

A summary of notes taken may be found in Exhibit 8. The barriers identified range from a shortage of scientific data on the fundamentals of selected energy technologies, to the need for process materials, to concerns with economic and regulatory factors impeding technology development.

Energy RD&D Needs

The group’s development of a prioritized list of energy RD&D needs began by generating a wide-ranging list of RD&D needs facing the chemical and pulp and paper industries. There was some concern expressed by participants early in this session that the task at hand was similar to previous efforts undertaken by the pulp and paper industry and that—due to the relatively short time allotted for this task—the list produced here could be incomplete in some important respects. Accordingly, it was suggested that group members try to focus on RD&D needs that are common to both the chemical and pulp and paper industries, producing a list of approximately 45 different RD&D topics. The group’s organization of these RD&D needs is shown in Exhibit 9. Following are the key points made during the discussion.

The highest priority item was the development of new and improved materials of construction, particularly those that are high temperature and corrosion-resistant; this falls in the category of basic research. Participants agreed that the demonstration of combustion processes for handling black liquor and future biomass fuels is very important. Gas clean-up technologies were also considered to be very important.

Other issues that were emphasised include: various fuels’ gasification effects, drying/water removal technology, instruments and controls, fate of non-process elements, forecasting energy costs and regulatory environment, and fundamentals of advanced reactor technology.

Risks/Payoffs

The result of the discussion about risks and payoffs is summarized in Exhibit 10. Although the

Exhibit 7
Discussion Session Participants
Energy Technology Needs
2A - “Yellow Group”

Name	Organization
Jim Wessel	Wessel & Associates
Bob Swindeman	ORNL
Mark Kirschner	BOC Gases
Jim Ciesar	Siemens Westinghouse
Mike Swanson	UNA Energy & Environmental Research Ctr.
Gary Stiegel	U.S. DOE/FETC
John Winslow	U.S. DOE/FETC
Amal Mansour	MTCI
Chris Shaddix	SNL
Bruce Hedman	Onsite Sycom
Robert DeCarrera	Georgia Pacific Corp.
Varin Ayala	Air Products & Chemicals, Inc.
Steve Vick	Global Energy
Merrill Smith	U.S. DOE/OIT
Bob Henseh	GTS Duratek
Richard Walters	U.S. DOE/Albany Research Center
Del Raymond	Weyerhaeuser

Facilitator: Marty Schweitzer, ORNL

Note Taker: Jim Wessel, Wessel & Associates

participants in the “Yellow Group” came from many different organizations and held diverse perspectives, there was substantial agreement on the importance of developing new and improved materials of construction, demonstrating combustion processes for handling black liquor and future biomass fuels, and developing gas cleanup technologies. The group also was able to reach consensus on where these and other high-priority energy RD&D needs should be placed on a risk/payoff matrix. Nearly all of these high priority items were rated as having potentially high payoffs, although the associated risk varied significantly among them.

Exhibit 8
Most Important Technical Barriers and Constraints for New Energy Technologies
“Yellow Group”

Fundamental Understanding of Gasification Research schedules do not integrate and are inadequate	Fuel Cells Technical Barriers New process chemistries - lack of building blocks	Safety Standards Required Gas turbine uncertainties (NO _x , gas stream)	Everyone Wants to Be Second Lack of capital commitment	Materials for Turbines and Other Equipment (High Temperature)	No One Wants Second Best Process Consistent market data	Feedstock Variability Technical risk and production
Impact of various fuels	Ability to handle biomass fuel	Robust hot gas clean-up	Technical data lacking for various feeds	Need for resources (low priority)	High temperature materials	Trace material effects
Need driving force for chemical industry (motivation)	Capital intensity of going offshore	Competition for capital	Sensing/sensors	Correlation test → real world	Lack of demonstration for black liquor gas	NIMBY
Process technology integration	Clearly defined environmental regulations needed	Fundamental understanding (communication between suppliers and users)	Lack of education about environmental regulations	Comparative data among gasification	Economic analysis policy (integration with existing capital)	
Fundamental understanding of combustion				Power products impact on market		

Exhibit 9
Most Important Energy RD&D Needs
“Yellow Group”
(◆ = Highest Priority)

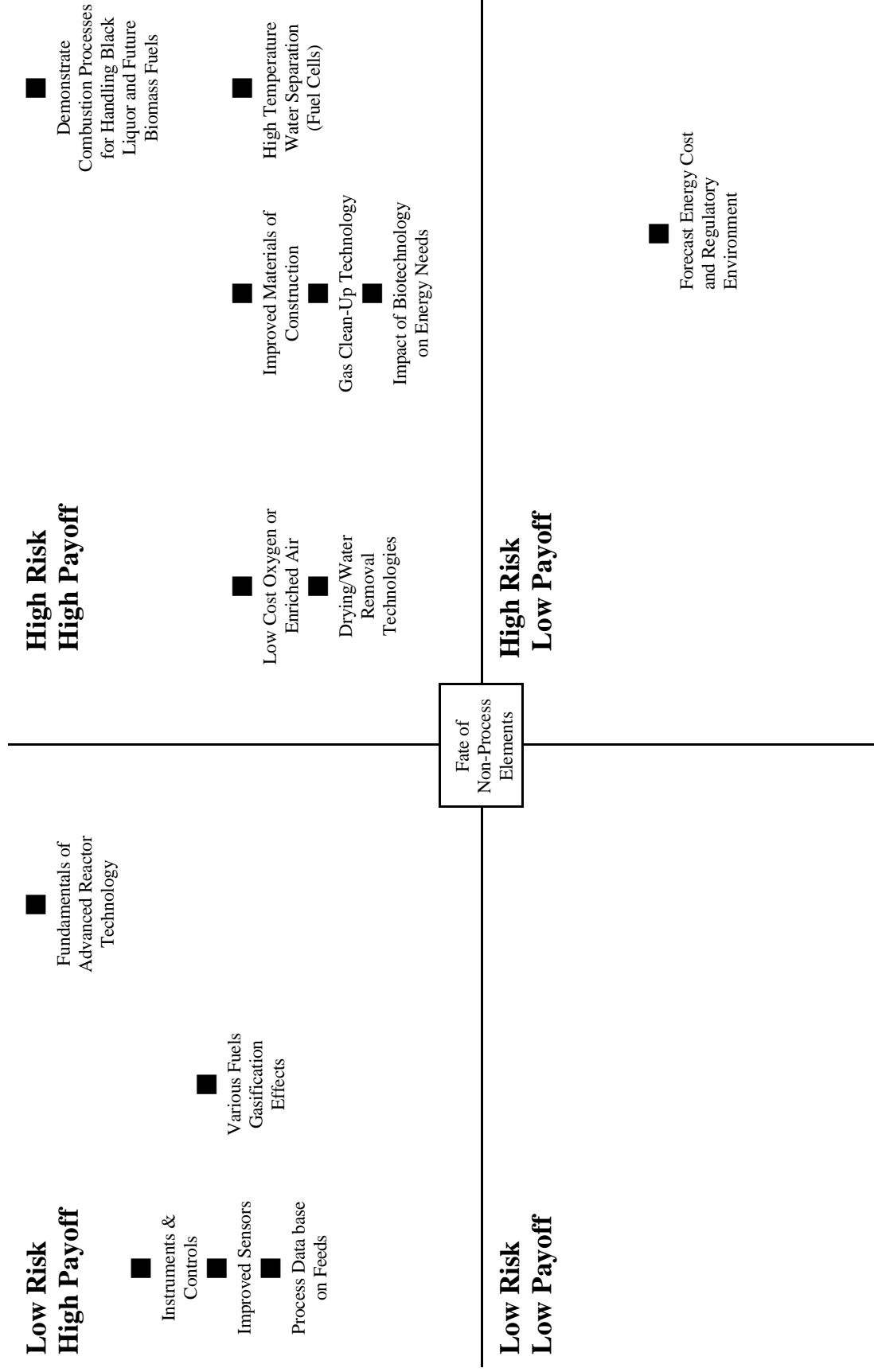
Basic Research	Process/ Technology Development	Institutional/ Policy Issues	Development of Instruments/ Methodologies	Technology Demonstration	Information
Tar formation process understanding	Drying/water removal technology ♦♦♦♦♦	Mechanism for reducing financial risks (upfront) ♦	Improved sensors - Thermocouples ♦♦	Trace contaminants, long term turbine tests ♦	Information on gasification (indexing and cross reference)
Develop programs for studying fundamentals of gasification reactions ♦	Separation research (fuel stream, toxic materials) ♦	Process engineering models for engineering firms for insurance purposes	Inexpensive/real time instrumentation and controls - long life ♦	Demonstrate combustion process for handling black liquor and future biomass fuels ♦♦♦♦♦♦♦♦♦♦ ♦	- Process database on feeds
Various fuels gasification effects ♦♦♦♦♦	Develop and apply computational technologies ♦	Process construction and deliverables - mechanism for developing industry concerns	Systems approach to problem solving	Independent assessment of competitive technologies	
Low level heat recovery ♦	Technology for increasing energy density of residual fuels	Forecast energy cost and regulatory environment - Stable environmental regulations ♦♦♦♦	Credible tests (methodology accelerated life tests)		
Environmental hygienic assessment of new systems	Low cost oxygen or enriched air ♦♦	Money for research (ideas for this) >50% government share	Instruments and controls ♦♦♦♦		
Develop new and improved materials of construction particularly high temperature and corrosion resistant - Understanding degradation of refractories ♦♦♦♦♦♦♦♦♦♦ ♦♦♦♦	Fate of NPE (solve problems caused by non-process elements) ♦♦♦♦ Gas clean-up technologies - With various feeds (hot gas clean-up) ♦♦♦♦♦♦♦♦♦♦ ♦♦♦♦♦♦♦♦♦♦	Maintain enthusiasm of managers and legislators for continued support for non-energy technologies	Develop process model (i.e., shutdown impact only facility by facility) Inexpensive methods of evaluating materials		
Low or non-thermal approaches to eliminate waste gases	Feed system technology development ♦ Minimization of waste or utilization of waste ♦	Co-production of chemicals and impact on economics			

Exhibit 9
Most Important Energy RD&D Needs
“Yellow Group”
(♦ = Highest Priority)

Basic Research	Process/ Technology Development	Institutional/ Policy Issues	Development of Instruments/ Methodologies	Technology Demonstration	Information
Combustion understanding fundamental research ♦ Impact of biotech on energy needs ♦♦ High temperature H ₂ separation (fuel cells) ♦♦ Fundamentals of advanced reactor technology ♦♦♦ Fundamental understanding of ash behavior		Focus on pre-competitive technology - Openness to sharing ideas			

Exhibit 10

Risk/Payoff Matrix
“Yellow Group”



5.5 Discussion Group 2B - (Green) - Energy Technology Needs

Members of the “Green Group” are listed in Exhibit 11.

Technical Barriers and Constraints

A summary of notes taken may be found in Exhibit 12. The following are key points made during the discussion.

Barriers that were discussed fall into three broad categories: process, financial, and institutional.

Critical process barriers focused on sensors and control systems to gather process data, the application of process modeling capabilities for verification and scale-up, and materials issues such as feedstock preparation, hot gas clean-up, and effluent and waste treatment.

Financial barriers include the difficulty in justifying the cost of implementing new energy-efficient or environmentally-benign technologies that may have initially higher costs.

Institutional barriers include avoiding being the first to deploy a new technology since plant operators tend to be extremely risk averse. There is usually resistance to change that needs to be overcome through an education process and by better communication among teams providing power technologies and those responsible for process technologies.

Energy RD&D Needs

A wide range of RD&D activities are needed to overcome existing barriers to developing and implementing advanced energy technologies. The group’s organization of these RD&D needs is shown in Exhibit 13. Following are the key points made during the discussion. The group’s list of RD&D needs that were considered basic research include several high priority items, hot gas clean-up and materials and coatings that can withstand both high temperatures and hostile chemical environments. The greatest RD&D needs in the applied pilot-scale validation category were: the design and development of a low BTU gas combustor that can handle biomass fuels with high nitrogen concentrations, the need for turbines able to tolerate and survive dirty syngas (this will require coordination among gas producers, coating and materials specialists, and turbine designers), and the general area of improved sensors/process monitors/controls. Another

Exhibit 11
Discussion Session Participants
Energy Technology R&D Discussion Group
“Green Group”

Name	Organization
Sy Ali	Allison Engine
Phil Amick	Dynegy Power Corp.
Don Anson	Battelle
Rick Balthaser	DOE
Richard Bartholomew	NIST/ATP
Cloyd Beasley	ORNL
Craig Fong	Lawrence Berkeley National Laboratory
David Huyng	DOE
Irene Kowalczyk	Westvaco Corp.
Kanwal Mahajan	DOE-FETC
Harry Morehead	Siemens Westinghouse Power Generation
Mike Ohl	Georgia-Pacific Corp.
Paul Raptis	Argonne National Laboratory
David Ruprecht	Air Products & Chemicals, Inc.
Ernest Soczka	EPRI
Ingrid Watson	DOE
Jennifer Williams	Global Energy
Anthony Yagiela	McDermott Technology, Inc.
Stephen Jasper	Dow Chemical Co.
Paul Tucker	International Paper

Facilitator: Joseph Badin, *Energetics, Incorporated*

Note Taker: Therese Stovall, *Oak Ridge National Laboratory*

significant RD&D need was the identification of the proper scale of development work, because chemical reactions and heat transfer may vary with the scale of the equipment. The most important need in the information category was identified as additional paper system studies on fuel cells and fuel cell/ATS hybrid systems and demonstration projects using black liquor feeds and other alternate biomass fuels.

Risks/Payoffs

The group took the top eight RD&D needs and placed them in a risk/payoff matrix as shown in Exhibit 14. There were no low risk/low payoff needs. Fuel cell system studies and demonstration were considered high risk and low payoff. This was due to technical risk of fuel cells using biomass streams and the need for process steam as well as reliable electricity. Low risk/high payoff RD&D needs were sensors/process monitors/controls and the need to determine proper scale for development work.

High risk/high payoff needs focused on materials issues. Metals exposed to harsh, caustic environments and high temperatures were the highest risk and payoff need. Next were coatings and material data at high temperatures for turbines and material handling system. The next priority was a trade-off between developing a turbine that can tolerate dirty gas and developing a hot gas clean-up system using conventional turbines. The last high risk/high payoff activity was the design and development of low BTU gas combustors that can handle biomass fuels with high nitrogen content.

Exhibit 12
Most Important Technical Barriers and Constraints for New Energy Technologies
“Green Group”

Process Barriers	Financial Barriers	Institutional Barriers
<p>Quantify pilot level to full scale-comfort with predictions</p> <p>Verification methods for scale-up by modeling</p> <p>Species characterization of gas/sensors non-destructive testing</p> <p>Process models needed - computational models - controllability</p> <p>Cleanliness of gas - <u>prove</u> hot-gas clean-up works</p> <p>Fuel cells not being considered - Competing technologies</p> <p>Materials, sulphur content of fluids - harsh environment</p> <p>Feedstock preparation - drying and size reduction</p> <p>Feed systems</p> <ul style="list-style-type: none"> - Unreliable - Want to handle multiple materials <p>Sensors and control systems for existing technologies (ruggedness of sensor)</p> <p>Application of modeling capability</p> <p>Effluents and waste (it is still going somewhere)</p>	<p>User's risk vs. reward - incremental nature of new technologies</p> <p>Motivation for shifting to new technology (thresholds)</p> <p>Definition of market size and accuracy of cost estimates</p> <p>Economic analysis from industry's viewpoint</p> <p>Cost too high causticizing effect/scale-up</p> <p>Proper recognition/credit for environmental benefits</p>	<p>Avoidance of being first</p> <p>Integration of technologies</p> <ul style="list-style-type: none"> - Lack of comfort/communication between teams (Power/pulp) <p>Education process - informing within different technology areas</p> <p>Overcome resistance to the unfamiliar - increase comfort level</p> <p>Firm power/reliability needs to improve before displacing current technologies</p> <p>How to get government agencies focussed on issue/problem</p>

Exhibit 13
Most Important Energy RD&D Needs
“Green Group”
(♦ = Highest Priority)

Fundamental (Basic R&D)	Applied Pilot-Scale Validation	Demo Industrial-Size (Commercial Scale Possible)	Optimization/Integration	Information
<p>Novel technologies for water removal <u>both</u> industries - multiple streams - Waste, feed, product ♦</p> <p>Energy utilization - increase pulping yield, improve chemical balances - IPSTA or university level research first</p> <p>Sensors - Black liquor liquid viscosity - Non contact/non-invasive - Temperature inside gasifier - Measure (optimum process) what we have not been able to measure before (non-contact NMR) ♦♦</p> <p>Improve fundamental chemical understanding - gasifier process (reduce cleanup needs) - Change process conditions to avoid waste generation ♦♦</p> <p>Pollution control that does not pollute (alternatives to incineration) ♦♦</p> <p>Model-needs more power/supercomputers ♦♦</p>	<p>Combustor level/design for low BTU gas - design, development and demonstration - Biomass fuels in particular (nitrogen concern) ♦♦♦♦♦♦♦♦</p> <p>Fuel preparation - more specifics for each fuel type - Water removal sizing - More specificity for each source - Fuel feed system development ♦♦</p> <p>Define “Clean” level required - Target syngas - Standards in place based on history with natural gas/oil</p> <p>Blended feedstocks with black liquor through any gasification - Mix sawdust or sludge with black liquor - use blend instead of different gasifiers for each</p>	<p>Materials handling - high temperature, dry particulates - ash - Review of demonstration projects “lessons learned” ♦♦</p> <p>Identify proper scale for development work - chemical may change (large volume - mixing heat transfer changes) ♦♦♦♦</p> <p>Black liquor demonstration deliverables - High availability ♦♦♦</p> <p>Models to develop control strategy ♦</p> <p>Biomass demonstration deliverables - Substitution for feeds and electricity possible</p>	<p><u>Look</u> for synergies within between industries (such as liquid methanol) <u>Open</u> investigation first - Process analysis/economics ♦♦</p> <p>Identify coproduction opportunities - power/steam/chemicals - Technical needs, e.g., catalysts</p>	<p>Develop profitable, valuable use for fly and bottom ash, fines, waste products</p> <p>Fuel cells with black liquor (ATS hybrid) biomass - alternate fuels - possible high payoff - Fuel cell/advanced turbine hybrid - 1) need paper system study 2) demonstration ♦♦♦♦♦</p>

Exhibit 13
Most Important Energy RD&D Needs
“Green Group”
(♦ = Highest Priority)

Fundamental (Basic R&D)	Applied Pilot- Scale Validation	Demo Industrial- Size (Commercial Scale Possible)	Optimization/ Integration	Information
Coatings (materials) - Coating (data at high temperatures) lamination/adhesion strength-composite material characteristics - Alkali-resistant coating - both turbines and material handling systems ♦♦♦♦♦ Black Box - hot clean-up to precede turbine of <u>all</u> containments - Tars, alkalis, ammonia, hydrogen sulfide ♦♦♦♦♦ Metals exposed to caustic solutions at high temperatures - Metal life = f[causticity, temperature (>200C) pressure (~30bar)] - Exposure to multiple elements - chloride, potassium ♦♦♦♦♦	- Prove fuel flexibility - also define “proof target” ♦♦♦♦ Turbines that can survive dirty gas (more tolerant) - Coordination --Gas producers --Coating/ materials --Turbine designers ♦♦♦♦♦ Model - Transients - Need pilot scale validation ♦♦♦♦ Sensors - Process/online - Environmental - Feed to controls ♦♦♦♦♦ Intelligent controls system development Sensors - Corrosion status online ♦			

Exhibit 14
Risk/Payoff Matrix
“Green Group”

Low Risk High Payoff	High Risk High Payoff	
	<div>■ Sensors/Process/Monitors/Controls</div> <div>■ Identify proper scale for development work</div>	<div>■ Turbines that can survive dirty gas - Coordination among gas producers, coatings/materials, turbine designers</div> <div>■ Coatings/Materials data at high temperatures: both turbines and material handling systems</div> <div>■ Metals exposed to caustic solutions at high temperatures.</div>
High Risk Low Payoff		<div>■ Fuel cells/ATS hybrid with black liquor or biomass - alt fuels</div>

6. CLOSING SESSION COMMENTS

During the closing session, each discussion group presented their results, leading to a limited amount of questions and answers from the participants. The floor was then opened up for general comments regarding the results of the discussion groups.

Some pulp and paper representatives felt strongly that the chemical industry's energy planning should have been brought up to the level of their own industry before the two industries were brought together. Workshop participants expressed difficulty in focusing on the cross-cut opportunities of the two industries, pointing out that this activity should occur after the chemical industry completes their own planning process. The chemical industry responded that they will probably go with proven technology and out-sourcing. They feel that there is no great need for R&D, pointing out that they already have about 200 gasification processes in place. Gasifiers are therefore new to the pulp and paper industry but not to the chemical industry. However, the chemical industry does recognize the need for further energy planning, hence their participation in this workshop. They felt that high-energy users within the chemical industry should be identified and targeted, rather than the whole diverse industry. There should also be more input from chemical industry people working on material development and gas clean-up.

One participant remarked that it's important not to let the focus on gasification obscure other valuable ideas, and to look at the breadth of suggestions from the discussion sessions. Many participants agreed that all priorities should be set by input exclusively from the chemical and pulp and paper industries and that additional reviews of the workshop results should be sought from these representatives. A focus group of "Chief Technical Officers" from major industries should be arranged to then review the priorities. Synergies between the industries can then be properly identified and all efforts should be focused in these areas.

It was mentioned that government funding decisions appear to be arbitrary, and participants questioned whether there are clear procedures and rules, and whether there are any stated goals for these decisions. It was suggested that within government regulation, finite lifetimes on environmental "grandfather" clauses could lead to more environmentally benign replacements. The issue of the final environmental disposal of all materials should also be considered.

There is value in bringing together the suppliers and end-users of the various technologies, such as occurred here with the turbine/gasification equipment manufacturers and industry representatives. One supplier learned about industry needs previously unrecognized.

A national laboratory representative wanted more time to present their technical research to the industry representatives. The mountain of death faced by technology developers is different from that faced by the industrial user. These developers also need a forum for sharing information.

7. WHAT COMES NEXT?

The Energy Performance Workshop was an initial step to identify common, energy-related technical barriers between the chemical and forest products industries, with the ultimate goal of establishing industrial energy sustainability. Workshop participants generated useful information and prompt actions must be taken to further advance these efforts. The Office of Industrial Technologies will use results from the workshop to develop an integrated, gasification program. On-going communication with suppliers and industry representatives, including plant visits and technical and programmatic discussions, will provide the framework for a strategic plan for an integrated DOE gasification initiative.

Other actions taken that will promote energy sustainability include interactions between OIT and NIST to implement an Internet workshop. This joint effort will leverage government funds to advance high-risk technologies that industry would not implement on its own. The Internet provides an expeditious mechanism for further discussion and will allow participants to propose approaches to resolve the technical barriers presented at the Energy Performance Workshop. More information will be disseminated once this Internet workshop is further developed. Additionally, there may be opportunities with industry organizations, such as Chemical Industry Environmental Technology Projects (CIETP), to identify common technical issues between the two industries.

The chemical industry is continuing its vision and planning process, which will help future collaboration between the chemical and pulp and paper industries. Meetings with competitors, suppliers, customers, and other key stakeholders are on-going to develop energy technology road maps. Additionally, included in the technical planning process will be a determination of the chemical industry's interest in augmenting combined cycle cogeneration applications. This workshop provided the forum to determine that there is interest but more work is needed to determine the level of interest. If the chemical industry decides to consider diversity of feed stock, synthesis gas, methanol, and electric power implementation, relevant technical barriers and opportunities for collaboration with the pulp and paper industry will result. Once these technology-planning efforts are complete, another workshop will be considered.

Continued dialogue among industry, government, laboratory, and academe is essential to determine industry needs and where government support will provide the most benefit to the nation. The Industries of the Future focus on research and development activities that improve resource efficiency and productivity in energy- and waste-intensive industries. The Forest Products Team and the Chemical Team, two of the eight vision areas, provide industry the opportunity to submit technical proposals through a solicitation process. These proposals may support gasification technologies or other related technical areas. For example, the Forest Products Team's Capital Effectiveness and Energy Performance task groups, two focus areas relevant to energy sustainability, grant awards annually to innovative ideas that can improve energy efficiency, waste reduction, and capital costs. Relevant areas to this task group mentioned at the workshop include drying processes, low-value heating utilization, and motor efficiency improvements. The Chemical Team also presents industry an opportunity to submit energy efficient and waste reduction proposals. Cross-cutting areas, such as separations, may offer solutions for the chemical industry as well as the pulp and paper industry. Integration of the

information generated from the workshop and subsequent discussions into future solicitations must be achieved in order to support industry's needs.

There are many actions that need to be taken to strive for industrial energy sustainability. It is important that we move quickly to advance the efforts set forth at the Energy Performance Workshop.

8. REFERENCE MATERIALS

Most of the information on OIT projects, organization charts, and bibliographies can be located on the Internet. The information resources catalog provides a list of all OIT reports, brochures, and documents that have been published. The Internet address is
www.oit.doe.gov/catalog/

The latest organization chart for the OIT is now on the Internet at the following address:
www.oit.doe.gov/About-OIT/

A list of all OIT sponsored projects can be found on the Industrial Projects Locator
www.oit.doe.gov/Access/locator/ipl.html

NIST's Advanced Tech Program website can be found at:
<http://www.atp.nist.gov/>

Fossil Energy's Clean Coal website (FETC) is at:
<http://www.fetc.doe.gov/>

The OIT Resource Room is also available for more information @ 202-586-2090.

Questions regarding the OIT gasification program can be directed to Tom King at 202-586-2387.

Pertinent DOE solicitation dates:

	<u>Requests for Proposals</u>	<u>Team Leader</u>
Chemical Team:	January/February 1999	Hank Kenchington 202-586-1878
Forest Products:	August 1999	Valri Robinson 202-586-0937